Health effects of passive smoking · 3

Series editors: J R Britton, S T Weiss

Parental smoking and prevalence of respiratory symptoms and asthma in school age children

Derek G Cook, David P Strachan

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Abstract

Background **– A systematic quantitative review of the evidence relating parental smoking to the prevalence of asthma and respiratory symptoms was conducted amongst school age children.**

Methods **– Sixty relevant studies were identified after consideration of 1593 articles selected by electronic search of the Embase and Medline databases using keywords relevant to passive smoking in children. The search was completed in April 1997 and identified 25 studies of asthma, 41 of wheeze, 34 of chronic cough, seven of chronic phlegm and six of breathlessness which were included in a quantitative overview.**

Results **– The pooled odds ratios for either parent smoking were 1.21 (95% CI 1.10 to 1.34) for asthma, 1.24 (95% CI 1.17 to 1.31) for wheeze, 1.40 (95% CI 1.27 to 1.53) for cough, 1.35 (95% CI 1.13 to 1.62) for phlegm, and 1.31 (95% CI 1.08 to 1.59) for breathlessness. Adjustment for confounding had little effect. Evidence of heterogeneity between studies appeared largely explicable by publication bias with a superfluity of small studies with large odds ratios. However, excluding these had little effect on the pooled odds ratios. The prevalence of all symptoms increased with the number of parents who smoked. While maternal smoking had a greater effect than paternal smoking, the effect of father only was clearly significant.**

Conclusions **– The relationship between parental smoking and respiratory symptoms seems very likely to be causal given statistical significance, robustness to adjustment for confounding factors, consistency of the findings in different countries, and evidence of dose response. The raised risk in households where the father, but not the mother, smoked argues for a postnatal effect.**

(*Thorax* 1997;52:1081–1094)

Keywords: parental smoking, tobacco smoke pollution, asthma, children.

Department of Public Health Sciences, St George's Hospital Medical School, Cranmer Terrace, London SW17 0RE, UK
D G Cook
D P Strachan

Correspondence to:
Dr D G Cook.

The first reports of an adverse effect of parental smoking on respiratory symptoms appeared in the early 1970s,[1–3] since when many epidemiological studies have reported on the association of parental smoking and respiratory diseases throughout childhood. The US Environmental Protection Agency Review[4] which was essentially narrative concluded that the evidence causally relating exposure to environmental tobacco smoke at home to respiratory symptoms was very strong amongst preschool children, but less compelling (though statistically significant) in children of school age. A more recent quantitative review[5] failed to distinguish between different exposures and ages.

In this part of a series of systematic and quantitative reviews of the effect of exposure to environmental tobacco smoke in childhood we summarise the evidence relating to the prevalence of respiratory symptoms and asthma in school age children (5–16 years) as assessed by population surveys. It follows on from our previous review of the effects of parental smoking on lower respiratory illness in infancy and early childhood.[6] Longitudinal and case-control studies of asthma incidence, prognosis, and severity will be reviewed separately.

Methods

REVIEW PROCESS

This paper is part of a series of reviews of the respiratory effects of exposure to environmental tobacco smoke in children. For this broader review published papers, letters, and review articles were selected by an electronic search of the Embase and Medline databases using the search strategy described elsewhere.[6] Briefly, all references to passive smoking were selected by the MESH heading *Tobacco smoke pollution* and/or text word combinations ({*passive, second hand, involuntary, parent*, maternal, mother*, paternal, father** or *household*} and {*smok*, tobacco** or *cigarette**}) in the title, keywords, or abstract. Papers were then restricted to children by selecting all papers classified as containing data on neonates or children under 18 and/or by relevant text words in the title or abstract. Embase searches were entirely based on text word searches. This search, completed in April 1997, yielded 3625 references of which 1593 contained keywords relevant to respiratory or allergic disease. These 1593 ab-

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stracts were reviewed and 692 were identified as of possible relevance to the assessment of respiratory health effects.

The 692 articles were reviewed and 100 were identified from their abstracts as potentially containing data relating prevalence of respiratory symptoms or asthma to exposure to environmental tobacco smoke. Thirty nine were excluded for the following reasons: 10 because although data on symptoms and environmental tobacco smoke were collected, no data were ever published,[7–16] a further seven presented no quantitative estimate of any effects though there was usually a comment on lack of statistical significance[17–22] or of statistical significance,[23] one study presented no separate data on children,[24] three were non-English publications,[25–27] two publications from a European collaborative study were more clearly presented as part of that,[28 29] five related to studies already included,[30–34] four studies presented data on other end points,[35–38] one was based on sharing a room with a smoker,[39] two were not population based,[40 41] and four publications related to a study from which we could not extract data.[42–45]

Where studies resulted in more than one publication we have used all available information to extract the data we sought. Longitudinal studies were included only where they published prevalence data and each study was included only once, usually based on its initial baseline survey.

Table 1 summarises the characteristics of 60 studies which were included in the quantitative overview; 57 were identified by the search strategy above, a further two were identified from citations in the articles reviewed,[150] while a "grey literature" publication summarising a pan European study covering 19 centres (largely unpublished) was identified by personal knowledge.[101]

The main aim of this European study[101] was to investigate the relationship between air pollution and respiratory health in school children. Data were also collected on number of smokers in the children's homes. A standard questionnaire to parents was used based on the WHO questionnaire.[146] Because of the uniform protocol, the size of the study (some 22 000 children), and because only two centres appear ever to have published the passive smoking data in a journal,[28 29] we present the data separately from our review of studies published in peer reviewed journals.

SYMPTOM QUESTIONNAIRES

With very few exceptions the studies reviewed here are based on data collected by self-completed questionnaires to parents. Inevitably definitions of asthma and symptoms vary and reflect the development of standard questionnaires. Many early studies, particularly in the UK, used the MRC respiratory questionnaire developed for adults.[106] The two most important characteristics of this questionnaire are (1) that it did not ask about symptoms in a defined period but about whether "a person usually coughed first thing in the morning" (cough usually am) or whether "a child's chest ever sounded wheezy or whistling" (wheeze ever) and (2) if the answer was yes to such a question a second question was usually asked eliciting severity. "Does he/she cough like this on most days or nights for as much as three months each year?" (persistent cough) or "Does he/she get this (wheeze) on most days or nights?" (persistent wheeze). The American Epidemiology Standardisation Project (AESP) built on this but also emphasised whether or not symptoms occurred only with or apart from colds in an attempt to distinguish allergic from non-allergic asthma.[107] More recently questionnaires have been developed which focus on symptoms in the past 12 months with a number of methods of assessing severity.[108] We have made explicit the differences in definitions where possible but in many instances no clear definition was given (indicated by a question mark in the tables).

EXPOSURE COMPARISONS

For each study for a given symptom measure we sought to obtain an odds ratio (rather than relative risk) and its 95% confidence limits for four exposures: any exposure in the household versus none (or equivalently either parent smokes versus neither smokes); mother only smokes versus neither parent smokes; father only smokes versus neither parent smokes; both parents smoke versus neither smoke. Where a study did not present data for children whose parents did not smoke but cited the effect of mothers smoking (versus father only or neither) and father smoking (versus mother only or neither), this is made clear. Few studies presented data on past exposure including smoking by the mother during pregnancy, but where they did this is discussed.

STATISTICAL METHODS

In many instances the odds ratio and 95% confidence limits were given or it was possible to calculate them from the raw data. In a few situations it was necessary to derive an approximate standard error (for the log odds ratio) based on the marginal values of the relevant 2×2 table. Where data allowed standardisation for age, sex, or occasionally another confounder the Mantel-Haenszel method was used to provide an adjusted value. In situations where odds ratios were given separately for different sexes a pooled odds ratio and 95% confidence interval was calculated by taking a weighted average (on the log scale) using weights inversely proportional to the variances. Similarly, if odds ratios were given for mother only versus neither, father only versus neither, and both smoke versus neither, a weighted average was taken to produce an estimate for either parent smokes versus neither if the latter could not be derived directly from the published data. In a few instances where number of cigarettes was fitted as a continuous variable in a logistic regression the estimate and its standard error were based on the estimated

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Table 1 List of included studies

Reference no.	*Year published*	*Country*	*Population*	*Response rate*	*Age*	*No. in ETS analyses*	*Asthma*	*Wheeze*	*Chronic cough*	*Chronic phlegm*	*Breathlessness*
1	72	UK	All school entrants in St Albans	NA	5	1119			•		
3	74	UK	All children at 7 schools in Aylesbury	93%	6–14	2426			•		
46	76	US	Stratified cluster sample of Tucson homes	72%	0–15	626	•	•	•	•	
47	77	US	Families with children from 3 towns	NA	7–18	816		•	•		
48	78	UK	Random sample of Derbyshire schools	86%	11–12	5835			•		•
49	79	NZ	Students attending 1 college	96%	12–18	715		•			
50	79	Japan	Children at 2 schools	99%	6–11	1896		•			
51	80	US	Random sample of children at school in East Boston in 1974 + sibs	42%	5–9	383		•	•		
52	82	US	Schools in 3 Arizona communities	76%	8–12	628	•	•	•	•	
53[a]	83	US	Stratified sample of Pennsylvania schools	93%	5–14	4071		•	•	•	
54	83	US	Children attending primary school in Iowa City	55%	6–12	1138			•		
55	84	UK	65 schools in Northern England	NA	8–19	6988			•		
56	84	US	6 cities	NA	6–9	8380		•	•		
57	86	Israel	Not clear. Near coal fired power station	86%	2 & 5 grade	NA	•	•	•		•
58	86	Korea	Children in households in Wonsung County	NA	0–14	3651			•		
59	86	US	Historical birth cohort	62%	6–10	223		•			
60	86	UK	Children born in 1976 from 1 general practice	83%	7–8	165	•	•	•		
61	86	US	Residents of Tecumseh, Michigan	NA	0–19	3460	•	•	•	•	
62[b]	88	UK	30 primary schools in Edinburgh	91%	7	1001		•	•		
63	88	UK	Stratified sample from 22 areas in England	75%	5–11	5169	•	•	•		
64	88	Sweden	7 areas near Norrkoping	94%	6 mo to 16	4990			•		
65	89	US	3 North American towns	>90%	7–17	1357		•	•	•	•
66	89	Canada	2 rural communities	81%	7–12	1317	•	•	•		
67[c]	89	Canada	5 rural communities in Ontario, 5 in Saskatchewan	81%	7–12	4003	•	•	•	•	
68	90	Netherlands	9 schools in southeast Holland	72%	6–12	1051		•	•		•
69	91	Australia	2 schools in a polluted and control area	72%	5–12	602		•			
70	91	UK	National stratified sample of children	>90%	5–11	14256	•	•	•		
71	91	Canada	Children in 30 communities	83	5–8	14059	•	•			
72	92	Italy	Random sample of schools in 3 areas	94%	7–11	2929	•		•		
73	93	Australia	Stratified sample of 36 schools	94%	8 & 12	4549		•			
74	93	Austria	3 zones of air pollution	88%	6–15	1626	•				
75	93	Australia	All Tasmanian 7 year olds	99%	7	8585		•			
76	93	Australia	All school children in 2 areas	86%	5–12	787		•			
77[d]	94	Costa Rica	Stratified random sample of 98 schools	89%	5–17	2534	•				
78	94	NZ	All children in town of Kawerau	82%	8–13	708		•			
79	94	UK	15 primary schools in 3 areas around Liverpool	92%	5–11	1872	•	•			•
80	95	NZ	All children in defined area	85	6–14	2614	•	•	•		
81	95	Hong Kong	4 selected schools – Chinese middle class	89	3–10	433	•				
82	95	Sweden	All schools in 1 area	97%	10–12	665		•	•		
82	95	Poland	1 school in Konin	97%	10–12	410		•	•		
82	95	Estonia	11 schools in Tallinn, 4 in Tartu	96%	10–12	1519		•	•		
83	95	Australia	All school entries in South Australia	73%	4–5	14124[e]		•			
84[f]	95	Israel	3 towns along coast	95%	Grade 2 & 5	6822	•	•	•		
85	95	Netherlands	2 primary schools	88%	6–12	470		•	•		•
86	95	UK	Children registered with large urban GP	98%	3–11	1077	•				
87	95	Norway	Two valleys in Western Norway	96%	7–13	620	•				
88	95	US	Stratified cluster sample of all US households	NA	<18	7578		•			
89	95	UK	Primary schools in Aberdeen	NA	8–13	259			•		
90	96	US	Birth cohort in Tucson	78%	6	987		•	•		
91	96	US	Older children of mothers giving birth in hospitals	91%	1–18	5171	•				
92	96	U. Arab Rep.	Unclear	86%	6–14	729	•				
93	96	Poland	Cluster sample of primary schools in 2 towns	75%	7–9	1622			•		
94	96	Canada	Children in 1 town (Humboldt)	NA	6–17	892	•				
95[g]	96	Hong Kong	17 schools in 2 areas with differing air pollution	96%	10–13	3521	•	•		•	
96	96	Jordan	Primary schools in and around Irbid City	90%	6–12	3186		•			
97	97	UK	Schools in Scottish Highlands	85%	12 & 14	1537		•	•		
98	97	Hong Kong	13 randomly selected schools	NA	13–14	>3733		•			
99	97	Turkey	Random sample of children	86%	7–12	5412	•	•			
100	97	US	Bogalusa Heart Study 1992–4 survey used	NA	5–17	2975	•				
101	82	EC Study	19 European centres	62–99%	6–10	22078		•			

ETS = environmental tobacco smoke; NA = not available from paper.
[a] Data for standard errors from ref 102.
[b] Data for cotinine in ref 34.
[c] Prevalence data from ref 103.
[d] Note error in table 3 in this paper.
[e] No. of families.
[f] See also ref 104.
[g] 1991 data used.

effect of the average number of cigarettes smoked.

The statistical methods used for meta-analyses have been previously described.[6] Quantitative meta-analysis was carried out by testing odds ratios for heterogeneity using the technique of Breslow and Day.[105] Pooled odds ratios were produced using a "random effects" model since, in a number of instances, there was evidence of statistically significant heterogeneity of the passive smoking effect between studies. In practice using a "random" as opposed to "fixed effects" model made little difference to point estimates but produced slightly wider confidence limits.

Results

ANY EXPOSURE VERSUS NONE AND EFFECTS OF ADJUSTMENT FOR POTENTIAL CONFOUNDING VARIABLES

Asthma

Twenty five papers were identified as containing quantitative information (table 2).[1] Most studies have reported on asthma ever (typically a positive response to "Has this child ever had asthma?"). A few have reported on current asthma, usually defined as in the past year, while a few specifically asked if the diagnosis had been made by a doctor. We have included under asthma one study which reported on wheezing consultations with the doctor.[46]

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Table 2 Studies of asthma prevalence

Ref. no.	Year published	Country	Definition of asthma	Age	Prevalence in unexposed (%)	Either parent (unadjusted) OR (95% CI)	Either parent (adjusted) OR (95% CI)	Adjusted for:	One parent only v neither OR (95% CI)	Both parents v neither OR (95% CI)	Mother only v neither OR (95% CI)	Father only v neither OR (95% CI)
46	76	US	Doctor diagnosis	0–15	7.6	3.53 (2.13 to 5.86)						
52	82	US	Not stated	8–12	4.1	1.61 (0.78 to 3.33)			1.36 (0.57 to 3.21)	1.94 (0.81 to 4.50)		
57	86	Israel	Ever	Grades 2 & 5	8.9	1.07 (0.74 to 1.56)					1.36 (0.87 to 2.14)	0.91 (0.59 to 1.39)
60	86	UK	Wheezing consultations	5–7	13	1.60 (0.56 to 4.60)						
61	86	US	Not stated	0–19	11.5		1.14 (0.92 to 1.41)	Age, sex, social class, family size	0.84 (0.63 to 1.13)	1.62 (1.18 to 2.22)	1.28 (0.68 to 2.40)	0.76 (0.56 to 1.04)
63	88	UK	Attack last year	5–11	4	1.00 (0.78 to 1.28)	1.18 (0.86 to 1.62)	Well adjusted except for area				
66	89	Canada	Current	7–12	3.6						1.11 (0.63 to 1.98)[b]	1.41 (0.80 to 2.48)[c]
67	89	Canada	Doctor diagnosis (ever)	7–12	4[a]						1.43 (1.09 to 1.88)[d]	
70	91	UK	In past year	5–11			1.02 (0.86 to 1.20)	Well adjusted				
71	91	Canada	Current	5–8	4.8	1.53 (1.30 to 1.81)	1.49[g]	Damp, gas cooking, type of heating, pets	1.4 (1.13 to 1.73)	1.59 (1.28 to 1.98)		
72	92	Italy	Ever (or symptoms)	7–11	6.3	1.4[g]	1.3 (0.9 to 1.8)	Sex, age, area, social etc		1.50 (1.04 to 2.20)	1.70 (1.04 to 2.70)	1.00 (0.70 to 1.50)
74	93	Austria	Doctor diagnosis	6–15	3.4						2.11 (1.22 to 3.67)[b]	
77	94	Costa Rica	Not stated	6–12							1.53 (1.14 to 2.04)[e]	1.19 (0.97 to 1.45)[c]
79	94	UK	Ever	5–11	17	1.09 (0.85 to 1.41)	1.06 (0.83 to 1.37)	Area				
80	95	NZ	Ever	6–7	25	1.06 (0.89 to 1.27)						
80	95	NZ	Ever	13–14	23	0.94 (0.79 to 1.13)						
81	95	Hong Kong	Current (?)	3–10	7	1.35 (0.60 to 3.06)						
84	95	Israel	Ever	Grades 2 & 5	9.6	1.19 (1.01 to 1.41)			1.13 (0.94 to 1.36)	1.33 (1.07 to 1.66)	1.27 (1.04 to 1.55)[b]	1.19 (1.00 to 1.41)[c]
86	95	UK	Current (?)	3–11	17	1.42 (1.05 to 1.92)	1.31 (0.96 to 1.81)	Social class		1.81 (1.16 to 2.84)	1.13 (0.71 to 1.80)	1.3 (0.86 to 1.97)
87	95	Norway	Ever	7–13	7.7						1.17 (0.66 to 2.07)[e]	0.72 (0.39 to 1.31)[c]
87†	95	Norway	Ever	7–13							1.26 (0.71 to 2.25)[f]	
87†	95	Norway	Ever	7–13							1.99 (1.08 to 3.67)[f]	
91	96	US	Doctor diagnosis	1–18	10.3	1.56 (1.30 to 1.88)	1.40 (1.13 to 1.72)	Ethnicity, gas stove, mould, maternal age, maternal allergy, no. children at home				
92	96	U. Arab R.	Ever	6–14	12.7	1.28 (0.82 to 1.99)						
94[h]	96	Canada	Doctor diagnosis (ever)	6–17	30.0	1.14 (0.72 to 1.79)			0.92 (0.53 to 1.63)	1.55 (0.84 to 2.84)	1.17 (0.71 to 1.95)[b]	1.00 (0.61 to 1.64)[c]
95	96	Hong Kong	Doctor diagnosis current (?)	8–11	6.1[a]		0.90 (0.69 to 1.17)		0.76 (0.55 to 1.07)	1.22 (0.78 to 1.92)		
99†	97	Turkey	Ever	7–12	13.1	1.41 (1.19 to 1.67)	1.35 (1.12 to 1.62)	Age, sex, place, animals, atopic family, breast fed				
99	97	Turkey	Current	7–12	4.6	1.34 (1.02 to 1.77)	1.28 (0.94 to 1.75)	Age, sex, place, animals, atopic family, breast fed				
100	97	US	Ever	5–17	15.9[a]		1.39 (1.11 to 1.72)	Age, sex, ethnicity				

[a] Prevalence overall.
[b] Mother currently smokes versus not.
[c] Father currently smokes versus not.
[d] Mother smoked in pregnancy and infancy versus not.
[e] Mother smoked prenatally versus not.
[f] Mother smoked post-natally versus not.
[g] No confidence limits available.
[h] Estimates produced by combining data for allergic and non-allergic subjects.
† Not included in meta-analysis.

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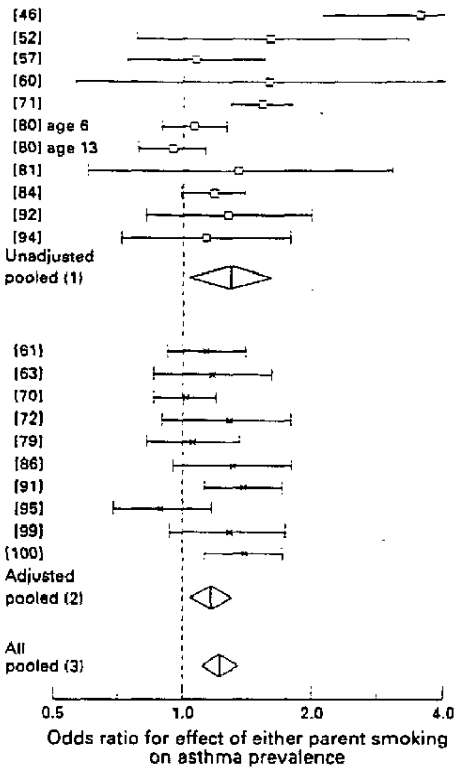

Figure 1 Odds ratios and 95% confidence limits for the effect of either parent smoking on asthma prevalence: upper part, studies not adjusting for potential confounders contributing to pooled odds ratio (1); lower part, studies adjusting for a variety of potential confounders contributing to pooled odds ratio (2); pooled odds ratio (3) is based on all studies. Studies ordered by date of publication.

The relative odds of asthma in children where either parent smoked compared with that in children where neither smoked is consistently above 1 (only two odds ratios were below 1[80 95]), but the majority of confidence limits include 1. The pooled estimate is 1.21 (95% CI 1.10 to 1.34), but there is evidence of heterogeneity between studies ($\chi^2_{20} = 49.6$, $p = 0.00025$). It is noticeable that those studies reporting the highest odds ratios were more likely to be early publications, to be small, and not to adjust for confounders (table 2, fig 1). The pooled odds ratio for the unadjusted studies is 1.30 (95% CI 1.04 to 1.62, $\chi^2_{10} = 35.7$, $p = 0.00009$). In contrast, the relative odds for those 10 studies which adjusted for various potential confounders are quantitatively consistent but slightly lower than for the unadjusted studies (pooled OR = 1.18 (95% CI 1.05 to 1.31, χ^2_9 for heterogeneity = 13.45, $p = 0.14$). For those seven studies reporting both adjusted and unadjusted odds ratios[63 71 72 79 86 91 99] we see very little effect of adjustment (table 2).

Wheeze

Forty one studies were identified with data on wheeze using a variety of definitions (table 3) which could broadly be grouped under three headings: wheeze ever, current wheeze, and persistent wheeze.

Of 29 studies reporting the effect of either parent smoking, the two studies with the highest odds ratios reported current persistent wheeze[51] and wheeze most days or nights[46] as opposed to wheeze ever or current wheeze. These two studies also reported the lowest prevalence rates (table 3), suggesting that the definitions probably reflected more severe wheeze. In two studies where both wheeze ever and wheeze most days or nights were reported from the same study the odds ratios were greater for wheeze most days or nights.[63 70]

As for asthma, all but one of the odds ratios for either parent smoking were above 1 with the highest odds ratios being from small studies which had not adjusted for potential confounders (fig 2). There was clear evidence of heterogeneity of effect amongst the unadjusted studies (pooled odds ratio 1.23 (95% CI 1.11 to 1.37), χ^2_{15} for heterogeneity = 35.7, $p = 0.0019$). Amongst the adjusted studies the pooled odds ratio was very similar (1.22 (95% CI 1.16 to 1.29)) and there was no evidence of heterogeneity ($\chi^2_{13} = 11.7$, $p = 0.55$). For those studies which provided both adjusted and unadjusted odds ratios the effect of adjustment was similarly very small (table 3), except for one early Japanese study.[50] The overall pooled odds ratio from all studies was 1.24 (table 6).

For the 19 centres participating in the EC study it was possible to extract data for wheeze ever. There was no evidence of heterogeneity between centres ($\chi^2_{18} = 18.6$, $p = 0.42$) and the pooled odds ratio across the 19 centres was 1.20 (95% CI 1.09 to 1.32).

Chronic cough

Thirty four studies of cough have been published using a variety of symptom definitions (table 4). While most are based on either the MRC or AESP questionnaires, the largest study invented its own question.[55] Two recent studies reported raised odds for cough without wheeze,[89 90] emphasising the importance of cough as a symptom. Unlike wheeze, there is no suggestion that the studies reporting the lowest prevalence rates (implying a more restrictive definition) contributed the highest odds ratios. The pooled odds ratio for the 19 studies not adjusting for anything was 1.47 (95% CI 1.27 to 1.70), χ^2_{18} for heterogeneity = 63.0, $p < 0.000001$), somewhat greater than for those studies adjusting for various factors (pooled OR = 1.30 (95% CI 1.19 to 1.41), χ^2_{10} for heterogeneity = 16.6, $p = 0.84$; fig 3). In the three studies reporting both adjusted and unadjusted figures[48 63 90] the effect of adjustment was small.

Chronic phlegm

Seven studies reported on phlegm, four using a definition of persistent phlegm and three being unclear (table 5). Three out of six studies reported significant odds ratios for either parent smoking, though all were above 1 (fig 4, top). The pooled odds ratio for either parent smoking

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Table 3 Studies of wheeze prevalence

Ref. no.	Year published	Country	Definition of wheeze	Age	Prevalence in unexposed (%)	Either parent (unadjusted) OR (95% CI)	Either parent (adjusted) OR (95% CI)	Adjusted for:	One parent only v neither OR (95% CI)	Both parents v neither OR (95% CI)	Mother only v neither OR (95% CI)	Father only v neither OR (95% CI)
46	76	US	Most days	0–15	1.4	2.86 (0.92 to 8.87)						
47	77	US	Ever	7–15	11.7	1.99 (1.28 to 3.10)			1.47 (0.90 to 2.4)	4.57 (2.45 to 8.51)	2.08 (1.14 to 3.79)	1.07 (0.57 to 1.99)
49	79	NZ	Current (or asthma)	12–18	11.6*						0.53 (0.26 to 1.05)[b]	
50	79	Japan	Current (or asthma)	6–11	9.8	2.08 (1.49 to 2.91)	1.15 (0.83 to 1.61)	Distance from major road				
51	80	US	Current and persistent	5–9	1.8	5.89 (0.79 to 44.1)			4.12 (0.52 to 32.9)	7.52 (0.99 to 57.3)		
52	82	US	Ever	8–12	27.9	1.32 (0.94 to 1.85)			1.01 (0.67 to 1.52)	1.8 (1.19 to 2.73)		
53	83	US	Persistent	5–14	7.2	0.93 (0.73 to 1.19)			1.08 (0.82 to 1.40)	0.74 (0.53 to 1.04)		
56	84	US	Persistent	6–9	9.9		1.2 (1.05 to 1.37)	Age, sex, city	1.11 (0.95 to 1.29)	1.32 (1.14 to 1.53)	1.18 (0.95 to 1.48)	1.08 (0.92 to 1.28)
57	86	Israel	Wheeze with cold	Grades 2–5	12.7	1.27 (0.95 to 1.70)					0.98 (0.66 to 1.46)	1.41 (1.05 to 1.98)
59	86	US	Current	6–10	10.2						2.16 (0.97 to 4.80)[b]	1.20 (0.55 to 2.62)[b]
60	86	UK	Ever	7–8	20	2.1 (0.87 to 5.1)						
61	86	US	Not stated	0–19	18.4		1.28 (1.08 to 1.52)	Age, sex, parental education	1.1 (0.87 to 1.39)	1.53 (1.19 to 1.97)	1.42 (0.85 to 2.36)	1.03 (0.80 to 1.33)
62	88	UK	In past year	7	12.1	1.04 (0.72 to 1.52)			1.00 (0.65 to 1.54)	1.13 (0.67 to 1.90)		
63†	88	UK	Ever	5–11	11	1.09 (0.95 to 1.26)	1.22 (1.02 to 1.45)	Age, sex, birthweight, obesity, social factors, mother's age, no. sibs				
63	88	UK	Most days/ nights	5–11	3	1.66 (1.01 to 2.12)	1.54 (1.16 to 2.04)	Age, sex, birthweight, obesity, social factors, mother's age, no. sibs				
65	89	US	Current	7–17	13		1.23 (0.88 to 1.72)	Sex, active smoking	1.32 (0.91 to 1.91)	1.14 (0.78 to 1.68)		
66	89	Canada	Ever	7–12	22.9						1.59 (1.24 to 2.03)	1.03 (0.80 to 1.31)
67	89	Canada	Persistent	7–12	9*						1.26 (0.95 to 1.67)[b]	
68	90	Netherlands	In past year	6–12	7.1*		1.86 (0.99 to 3.49)	Age, parental education				
69	91	Australia	In past year	5–12	17.3		1.4 (0.8 to 2.3)	Age, sex, area, dust mite allergy				
70†	91	UK	Ever	5–11			1.11 (1.00 to 1.22)	Age, sex, country, birthweight, obesity, social factors, mother's age, no. sibs, ethnicity, gas cooking				
70	91	UK	Most days or nights	5–11			1.31 (1.11 to 1.55)	Age, sex, country, birthweight, obesity, social factors, mother's age, no. sibs, ethnicity, gas cooking				
71	91	Canada	Current	5–8	7.2	1.6 (1.39 to 1.83)	1.55[b]	Dampness, gas cooking	1.39 (1.17 to 1.65)	1.72 (1.44 to 2.05)		
73	93	Australia	Ever	8 and 12	22*						1.36 (0.96 to 1.93)	0.94 (0.70 to 1.26)
75	93	Australia	Ever (or asthma)	7	14.3*						1.35 (1.20 to 1.50)[b]	1.10 (0.97 to 1.23)[b]
76	93	Australia	Current	5–12	20.0*		1.02 (0.71 to 1.47)	Age, sex, area, atopy				
78	94	NZ	Current	8–13	22	1.0 (0.7 to 1.4)						
78	94	NZ	Current	8–13	18						1.4 (1.0 to 2.1)[b]	
78†	94	NZ	Current	8–13	22						0.9 (0.7 to 1.4)[b]	
79	94	UK	Ever	5–11	18	1.32 (1.03 to 1.69)	1.28 (1.00 to 1.64)	Area				
80	95	NZ	Current	6–7	23	1.06 (0.88 to 1.27)						
80	95	NZ	Current	13–14	28	1.16 (0.98 to 1.37)						
82	95	Sweden	Not stated	10–12	11.9			Sex, atopy, damp, overcrowding			0.73 (0.41 to 1.29)	
82	95	Poland	Not stated	10–12	9.4			Sex, atopy, damp, overcrowding			1.54 (0.91 to 2.60)	
82	95	Estonia	Not stated	10–12	7.1			Sex, atopy, damp, overcrowding			1.45 (0.94 to 2.24)	
83†	95	Australia	Past year	4–5		1.12[f]	NS	Method of heating & ventilation				
83	95	Australia	Ever	4–5		1.24[f]	1.18 (1.08 to 1.30)	Method of heating & ventilation				
84	95	Israel	Wheeze with cold	Grades 2 & 5	13.1	1.25 (1.09 to 1.44)			1.24 (1.07 to 1.45)	1.27 (1.06 to 1.53)	1.25 (1.06 to 1.48)[b]	1.27 (1.10 to 1.47)[b]

cont.

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Table 3 contd

Ref. no.	Year published	Country	Definition of wheeze	Age	Prevalence in unexposed (%)	Either parent (unadjusted) OR (95% CI)	Either parent (adjusted) OR (95% CI)	Adjusted for:	One parent only v neither OR (95% CI)	Both parents v neither OR (95% CI)	Mother only v neither OR (95% CI)	Father only v neither OR (95% CI)
85	95	Netherlands	Ever (?)	6–12	14.7*		1.08 (0.67 to 1.74)	Age, sex, damp, father's education, dog, unvented geyser				
88†	95	US	Current (or asthma)	0–17				Sex, race, area, social factors, family size			1.36 (1.14 to 1.62)	0.83 (0.67 to 1.02)
88†	95	US	Current (or asthma)	0–2	11.6			Sex, race, area, social factors, family size			1.90 (1.23 to 2.94)	
88†	95	US	Current (or asthma)	3–5	8			Sex, race, area, social factors, family size			1.53 (0.99 to 2.37)	
88	95	US	Current (or asthma)	6–12	7.9			Sex, race, area, social factors, family size			1.35 (1.01 to 1.81)	
88	95	US	Current (or asthma)	13–17	8.5			Sex, race, area, social factors, family size			1.07 (0.76 to 1.49)	
90	96	US	Current	6	26.4	1.32 (0.98 to 1.80)						
95	96	Hong Kong	Not stated	10–11	7.1[c]		1.01 (0.79 to 1.29)	Age, sex, district, father's education, housing	0.94 (0.69 to 1.28)	1.70 (1.15 to 2.54)		
96	96	Jordan	In past 3 years	6–12	12.4*						1.87 (1.28 to 2.75)[b]	1.31 (1.05 to 1.63)[c]
97	97	UK	Current	12 & 14	16.6	1.13 (0.87 to 1.48)					1.15 (0.84 to 1.56)	
98	97	Hong Kong	Current[a]	13–14	12*	1.14 (0.92 to 1.42)						
98†	97	Hong Kong	Severe attack[a]	13–14	2.4*	1.05 (0.64 to 1.74)						
99†	97	Turkey	Ever	7–12	16.1	1.29 (1.10 to 1.51)	1.25 (1.05 to 1.48)	Age, sex, place, animals, atopic family, breast fed				
99	97	Turkey	Current	7–12	4.1	1.39 (1.02 to 1.90)	1.52 (1.10 to 2.09)					

*Prevalence overall.
[b]Mother currently smokes versus not.
[c]Father currently smokes versus not.
[d]Mother smoked in pregnancy and infancy versus not.
[e]Mother smoked prenatally versus not.
[f]No confidence limits available.
[g]Based on written questionnaire.
[h]Primary carer smokes versus not.
†Not included in meta-analysis.

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Source: https://www.industrydocuments.ucsf.edu/docs/gyjj0001

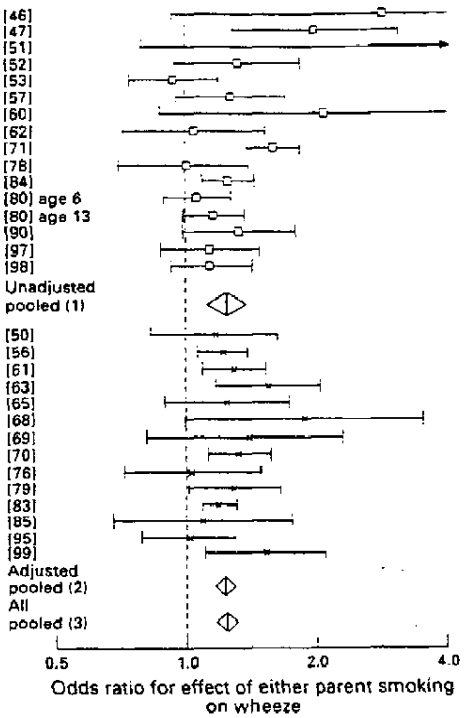

Figure 2 Odds ratios and 95% confidence limits for the effect of either parent smoking on wheeze prevalence: upper part, studies not adjusting for potential confounders contributing to pooled odds ratio (1); lower part, studies adjusting for a variety of potential confounders contributing to pooled odds ratio (2); pooled odds ratio (3) is based on all studies. Studies ordered by date of publication.

was 1.35 (95% CI 1.13 to 1.62) with no evidence of heterogeneity between studies (χ^2_5 for heterogeneity = 4.3, p = 0.51).

Breathlessness

Six studies reported on shortness of breath using various definitions (table 5). Only two studies reported statistically significant effects though all bar one of the odds ratios were above 1 (fig 4, bottom). The pooled odds ratio for either parent smoking was 1.31 (95% CI 1.08 to 1.59) with no evidence of heterogeneity (χ^2_5 for heterogeneity = 4.6, p = 0.47).

POOLED ODDS RATIOS

The pooled odds ratios for smoking by either parent compared with neither are remarkably consistent across different outcomes, ranging from 1.21 for asthma to 1.40 for cough (table 6). For asthma, wheeze, and cough where there are sufficient studies to justify a pooled analysis there is clear evidence of an increased risk of respiratory symptoms if only one parent smokes, whether this is the mother only or the father only. The effect of mother only smoking appears to be greater than that for father only, but a formal comparison of mother only and father only is not possible as it requires within study estimates of standard errors for the calculation. There is also clear evidence of dose response with number of parents smoking, the odds ratios for both parents smoking being greater than for one parent only in all cases (table 6).

PASSIVE SMOKING EFFECTS AT DIFFERENT AGES

Comparison of different studies is unlikely to give a valid assessment of the risks associated with parental smoking at different ages because of the considerable overlap of age range in many studies as well as different definitions of symptoms. A number of within study comparisons are, however, possible. A large US study found clear evidence of a fall in the odds ratio for current wheeze from 1.9 amongst infants to 1.07 amongst teenagers[88] (table 3). Similarly, a large questionnaire survey from the UK found a clear fall in the odds ratio for cough from 1.61 at age 8–10 to 1.50 at 11–13 to 1.12 at 14–19,[55] while a Korean study[56] found that the odds ratio for cough in the past two weeks fell from 3.9 under age 5 to 2.6 at ages 6–11 to 2.0 at ages 12–14 (table 4). In contrast, a relatively small New Zealand study found slightly greater odds ratios for current wheeze and for cough at 13–14 years than at age 6–7 (tables 3 and 4).[80]

PAST EXPOSURE

Few studies have analysed the effects of past as opposed to current exposure. In one of the early studies Colley[3] reported that prevalence of cough during the day or at night was slightly lower in children of ex-smokers (14.2% of 634) than in the offspring of never-smokers (15.6% of 320). More recently a New Zealand study[74] found that smoking by the current primary carer was associated with current wheeze (odds ratio = 1.4 (95% CI 1 to 2.1)) whereas maternal smoking during pregnancy was not (odds ratio = 0.9 (95% CI 0.7 to 1.4)). A Norwegian study[87] found that postnatal smoking by the mother was more strongly related to asthma than either prenatal or current smoking (table 2). A recent Scottish study[97] reported slightly stronger effects for current maternal as opposed to maternal antenatal smoking for both wheeze (odds ratios 1.15 versus 1.10) and cough (1.93 versus 1.42).

Discussion

CONSISTENCY OF EVIDENCE ACROSS DIFFERENT SYMPTOMS

We have found a clear relationship between parental smoking and the prevalence of asthma and respiratory symptoms in school children which is very unlikely to be due to chance alone. The magnitude of the effects is similar for the different outcome measures and, with few exceptions, is consistent across studies and in different countries. The estimated effects were robust to adjustment for a wide range of environmental factors, particularly for wheeze. We conclude that residual confounding is unlikely to be an issue. While there is clear evidence of publication bias, with a lack of small

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Table 4 Studies of cough prevalence

Ref. no.	Year published	Country	Definition of cough	Age	Prevalence in unexposed (%)	Either parent (unadjusted) OR (95% CI)	Either parent (adjusted) OR (95% CI)	Adjusted for:	One parent v neither OR (95% CI)	Both parents v neither OR (95% CI)	Mother only v neither OR (95% CI)	Father only v neither OR (95% CI)
1	72	UK	Recent recurrent	5	3.1	0.89 (0.44 to 1.80)			0.62 (0.25 to 1.46)	1.4 (0.61 to 3.2)		
3	74	UK	Usually, in winter	6-14	14.7	1.47 (1.17 to 1.85)			1.25 (0.94 to 1.66)	1.66 (1.28 to 2.16)		
46	76	US	Persistent	0-15	4.8	2.28 (1.20 to 4.32)						
47	77	US	&/or phlegm usual	7-18	12.8	1.22 (0.82 to 1.82)			1.06 (0.68 to 1.63)	1.99 (1.06 to 3.73)	1.1 (0.56 to 2.15)	1.04 (0.64 to 1.69)
48	78	UK	Day or night	11-12	19.4	1.56 (1.36 to 1.79)	1.36 (1.12 to 1.64)	Active smoking, sex	1.2 (0.96 to 1.49)	1.57 (1.25 to 1.94)		
51	80	US	& phlegm	5-9	1.7	1.88 (0.24 to 15.0)			1.64 (0.18 to 15.0)	2.09 (0.25 to 17.8)		
52	82	US	Not stated	8-12	14.1	2.03 (1.35 to 3.06)			1.84 (1.15 to 2.95)	2.29 (1.41 to 3.73)		
53	83	US	Chronic	5-14	6.3	1.21 (0.95 to 1.54)			1.12 (0.84 to 1.49)	1.35 (1.00 to 1.83)		
54	83	US	With colds	6-12	30	1.40 (1.09 to 1.80)			1.33 (1.00 to 1.78)	1.50 (1.10 to 2.04)	1.38 (0.87 to 2.17)	1.32 (0.96 to 1.80)
55	84	UK	Gets a lot	8-19	22	1.47 (1.31 to 1.66)			1.36 (1.19 to 1.56)	1.64 (1.41 to 1.91)	1.36 (1.15 to 1.62)	1.34 (1.13 to 1.59)
55	84	UK	Gets a lot	8-10	33.5	1.60 (1.33 to 1.96)						
55	84	UK	Gets a lot	11-13	17.5	1.50 (1.26 to 1.79)						
55	84	UK	Gets a lot	14-19	8.5	1.12 (0.83 to 1.52)						
56	84	US	Persistent	6-9	7.7		1.19 (1.02 to 1.39)	Age, sex, city	1.09 (0.91 to 1.30)	1.38 (1.16 to 1.63)	0.99 (0.75 to 1.29)	1.13 (0.91 to 1.36)
57	86	Israel	With sputum	Grades 2 & 5	6	1.17 (0.77 to 1.78)					1.22 (0.72 to 2.07)	1.15 (0.73 to 1.81)
58	86	Korea	In past 2 weeks	0-14	5	3.04 (2.09 to 4.43)			3.2 (2.11 to 4.85)	3.00 (2.05 to 4.38)		
60	86	UK	Night	7-8	49.1	1.7 (0.84 to 3.44)						
61	86	US	Not stated	0-19	8.5		1.00 (0.78 to 1.27)	Age, sex, parental education	0.93 (0.67 to 1.30)	1.27 (0.89 to 1.81)	0.78 (0.37 to 1.64)	0.97 (0.67 to 1.41)
62	88	UK	At night in past month	7	9	1.91 (1.29 to 2.82)			1.64 (1.05 to 2.56)	2.45 (1.5 to 4.02)		
63	88	UK	Cough usually am	5 11	4	1.24 (1.00 to 1.53)	1.24 (0.94 to 1.65)	Age, sex, birthweight, obesity, social factors, mother's age, no. sibs				
63	88	UK	Usually day/night	5 11	8	1.46 (1.27 to 1.68)	1.26 (1.02 to 1.56)	Age, sex, birthweight, obesity, social factors, mother's age, no. sibs				
64	88	Sweden	Exercise induced	6 mo to 16 yr	5.1	1.39 (1.10 to 1.76)						
65	89	US	Persistent	7-17	0.9		2.02 (0.68 to 6.03)	Sex, active smoking	1.84 (0.55 to 6.18)	2.23 (0.69 to 7.19)		
66	89	Canada	With phlegm	7-12	5.3						0.98 (0.60 to 1.62)	0.85 (0.52 to 1.39)
67	89	Canada	Persistent	7-12	8*						1.45 (1.13 to 1.87)[d]	
68	90	Netherlands	Persistent	6-12	4.6*		2.46 (1.07 to 5.64)	Age, parental education				
70	91	UK	Usually	5-11			1.25 (1.13 to 1.38)	Age, sex, country, birthweight, obesity, social factors, mother's age, no. sibs, ethnicity, gas cooking				
72	92	Italy	With phlegm	7-11	5.5	1.3[e]	1.3 (0.9 to 1.9)	Sex, age, area, social class etc.		1.7 (1.1 to 2.5)	1.2 (0.7 to 2.0)	1 (0.7 to 1.6)
72	92	Italy	Night	7-11	3.4	1.8[e]	1.8 (1.2 to 2.7)	Sex, age, area, social class etc.		2.5 (1.6 to 3.9)	1.5 (0.8 to 2.8)	1.2 (0.8 to 2.0)
80	95	NZ	Night	6-7	30	0.91 (0.77 to 1.08)						
80	95	NZ	Night	13-14	24	1.78 (1.50 to 2.11)						
82	95	Sweden	Night	10-12	8.4			Sex, atopy, damp, overcrowding			2.09 (1.51 to 2.90)[b]	
82	95	Poland	Night	10-12	6.7			Sex, atopy, damp, overcrowding			1.10 (0.62 to 1.93)[b]	
82	95	Estonia	Night	10-12	7.4			Sex, atopy, damp, overcrowding			2.27 (1.55 to 3.32)[b]	
84	95	Israel	With sputum	Grades 2 & 5	8.1	1.25 (1.06 to 1.49)		Age, sex, damp, father's education, dog, unvented geyser	1.12 (0.93 to 1.36)	1.51 (1.22 to 1.87)	1.42 (1.17 to 1.73)[b]	1.25 (1.05 to 1.48)[c]
85	95	Netherlands	Chronic	6-12	12.6*		1.10 (0.67 to 1.8)					
89	95	UK	Isolated persistent nocturnal cough	8-13	Not stated	1.61 (0.70 to 3.70)						
90	96	US	Persistent	6	27.4	1.44[f] (1.07 to 1.94)						
90†	96	US	Persistent without wheeze	6	11.8	1.67[f] (1.10 to 2.54)	1.93[f] (1.09 to 3.45)	Sex, hay fever, LRI in first year				
93	96	Poland	Chronic	7-9	31.9*		1.3 (1.02 to 1.71)	Crowding				
97	97	UK	Chronic	12 & 14	7.2	1.58 (1.31 to 2.27)					1.91 (1.30 to 2.85)	

*Prevalence overall. [b]Mother currently smokes versus not. [c]Father currently smokes versus not. [d]Mother smoked in pregnancy and infancy versus not. [e]No confidence limits available. [f]Reference group: children without cough or wheeze. †Not included in meta-analysis.

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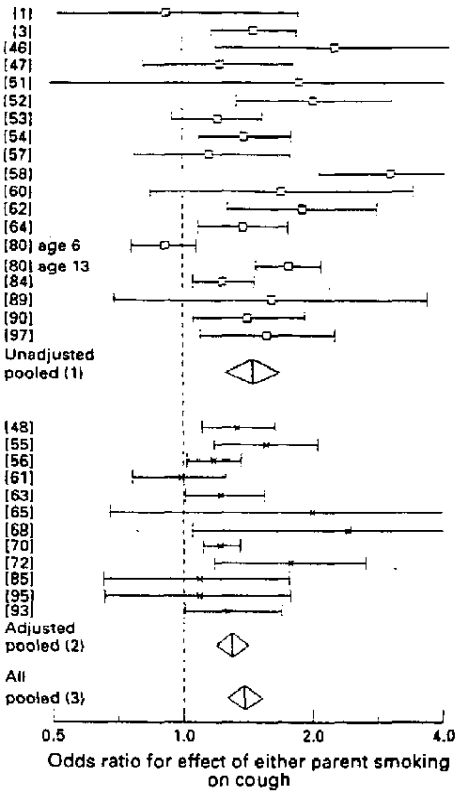

Figure 3 Odds ratios and 95% confidence limits for the effect of either parent smoking on cough prevalence: upper part, studies not adjusting for potential confounders contributing to pooled odds ratio (1); lower part, studies adjusting for a variety of potential confounders contributing to pooled odds ratio (2); pooled odds ratio (3) is based on all studies. Studies ordered by date of publication.

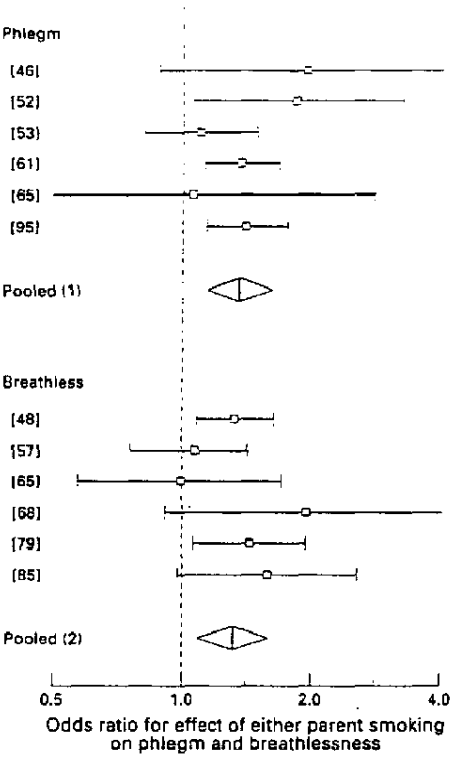

Figure 4 Odds ratios and 95% confidence limits for the effect of either parent smoking on: upper part: phlegm (adjusted and non-adjusted) contributing to pooled odds ratio (1); lower part, shortness of breath (adjusted and non-adjusted) contributing to pooled odds ratio (2). Studies ordered by date of publication.

negative studies, the effect of this on the pooled odds ratios is very slight as so many large studies have been published. The similarity between the pooled odds ratio for wheeze from published studies and in the EC study is further reassurance that the association is not an artefact of selective publication. It is, however, interesting that the two centres which published data in journals (Middlesborough[28] and Ardennes[29]) had above average odds ratios of 1.36 and 1.37, respectively.

DOSE RESPONSE

Evidence for a causal interpretation is further strengthened by the clear increase in odds with number of parents smoking which is highly statistically significant for asthma, wheeze, and cough and consistently seen in nearly all studies. The effect of mother smoking appears greater than the effect of father only, but there is nevertheless clear evidence for a small effect from paternal smoking. The greater effect of maternal smoking is consistent with the greater effects of maternal smoking on children's cotinine levels at school age.[110] Given that postnatal exposure from the mother is greater than from the father, and we find evidence of an effect from the father only smoking, much of the maternal effect is probably postnatal. Surprisingly few studies have examined number of cigarettes per day and looked for dose response trends amongst exposed children (as opposed to looking for a trend with non-exposed children included), but it seems likely that the greater effect seen amongst children in households where both parents smoke is due to both heavier smoking by the mother as well as the father.

EFFECTS OF PARENTAL SMOKING IN THE PAST

On balance the limited evidence suggests that the prevalence of respiratory symptoms is not raised amongst children of ex-smokers[178] and is more closely related to current maternal smoking than to prenatal smoking by the mother.[87 97] While compatible with the hypothesis that current rather than past exposure is what matters, the evidence is not overwhelming since so few data have been published and ex-smokers are likely to have been lighter smokers. The major limitation of all these studies is that the exposure data were not collected prospectively and recall bias is a potential problem. This issue would be better addressed by looking

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Source: https://www.industrydocuments.ucsf.edu/docs/gyjj0001

Table 5 Studies of phlegm and breathlessness

Ref. no.	Year published	Country	Outcomes	Age (years)	Prevalence in unexposed (%)	Either parent (unadjusted) OR (95% CI)	Either parent (adjusted) OR (95% CI)	Adjusted for:	One parent OR (95% CI)	Both parents OR (95% CI)	Mother only OR (95% CI)	Father only OR (95% CI)
46	76	US	Phlegm persistent	0-15	3.1	1.96 (0.88 to 4.38)						
52	82	US	Sputum?	8-12	6.7	1.85 (1.05 to 3.25)			1.77 (0.93 to 3.37)	1.95 (1.00 to 3.81)		
53	83	US	Phlegm chronic	5-14	4.1	1.09 (0.81 to 1.48)			1.18 (0.84 to 1.67)	0.98 (0.66 to 1.49)		
61	86	US	Phlegm?	0-19	11		1.37 (1.12 to 1.68)	Age, sex, social class, family size	1.25 (0.95 to 1.65)	1.53 (1.14 to 2.05)	1.3 (0.71 to 2.39)	1.24 (0.91 to 1.70)
65	89	US	Phlegm persistent	7-17	1.4		1.05 (0.40 to 2.79)	Sex	0.76 (0.23 to 2.51)	1.37 (0.47 to 4.03)		
67	89	Canada	Phlegm persistent	7-12	8.0[a]			Parents' symptoms, gas cooking, not area			1.15 (0.90 to 1.47)[b]	
95	96	Hong Kong	Phlegm?	10-13	8.7[a]		1.40 (1.13 to 1.75)	Age, sex, area, housing, father's education	1.26 (0.96 to 1.64)	1.75 (1.19 to 2.56)		
48	78	UK	SOB on exertion	11-12	9.8	1.42 (1.22 to 1.66)	1.33 (1.08 to 1.65)	Active smoking, sex	1.26 (0.99 to 1.60)	1.42 (1.11 to 1.83)		
57	86	Israel	SOB	Grades 2 & 5	10.7	1.07 (0.76 to 1.43)					1.26 (0.85 to 1.87)	0.92 (0.64 to 1.32)
65	89	US	SOB when hurrying	7-12	4.6		0.99 (0.57 to 1.71)	Active smoking, sex	1.05 (0.57 to 1.95)	0.93 (0.49 to 1.77)		
68	90	Netherlands	SOB + wheeze (past yr)	6-12	4.6[a]		1.95 (0.91 to 4.19)	Age, parental education, not school				
79	94	UK	SOB ever	5-11	10	1.54 (1.13 to 2.09)	1.44 (1.06 to 1.95)	Area				
85	95	Netherlands	SOB	6-12	11.9[a]		1.58 (0.98 to 2.56)	Age, sex, damp, father's education, dog, unvented geyser				

SOB = short of breath.
[a] Prevalence overall.
[b] Mother smoked in pregnancy and infancy versus not.

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Source: https://www.industrydocuments.ucsf.edu/docs/gyjj0001

Table 6 Summary of pooled random effects odds ratios with 95% confidence intervals (number of studies in parentheses)

	Either parent smokes			*One parent smokes*			*Both parents smoke*			*Mother only smokes*			*Father only smokes*		
	OR	*(95% CI)*	*(n)*	*OR*	*(95% CI)*	*(n)*	*OR*	*(95% CI)*	*(n)*	*OR*	*(95% CI)*	*(n)*	*OR*	*(95% CI)*	*(n)*
Asthma	1.21	(1.10 to 1.34)	(21)[a]	1.04	(0.78 to 1.38)	(6)	1.50	(1.29 to 1.73)	(8)	1.36	(1.20 to 1.55)	(11)	1.07	(0.92 to 1.24)	(9)
Wheeze#	1.24	(1.17 to 1.31)	(30)[a]	1.18	(1.08 to 1.29)	(11)	1.47	(1.14 to 1.90)	(11)	1.28	(1.19 to 1.38)	(18)[b]	1.14	(1.06 to 1.23)	(10)
Cough	1.40	(1.27 to 1.53)	(30)[a]	1.29	(1.11 to 1.51)	(15)	1.67	(1.48 to 1.89)	(16)	1.40	(1.20 to 1.64)	(14)[b]	1.21	(1.09 to 1.34)	(9)
Phlegm*	1.35	(1.13 to 1.62)	(6)	1.25	(0.97 to 1.63)	(5)	1.46	(1.04 to 2.05)	(5)						
Breathlessness*	1.31	(1.08 to 1.59)	(6)												

Excluding EC study, in which the pooled odds ratio was 1.20.
* Data for phlegm and breathlessness restricted as several comparisons are based on fewer than five studies.
[a] Two age groups for reference 80 included as separate studies.
[b] Reference 82 included as three separate studies.

at the effects of change in smoking habit on symptoms longitudinally.

EFFECT OF PARENTAL SMOKING AT DIFFERENT AGES

For a given level of parental smoking, the odds ratios reported in this review of school children are somewhat lower than those we found in our review of the effects of parental smoking on lower respiratory illness in infancy and early childhood where the pooled odds ratio for either parent smoking was 1.57 (95% CI 1.42 to 1.74).[6] While this is consistent with previous claims of smaller effects in older children, the contrast is less marked than has been suggested.[4] Moreover, it is clearly important to consider the level of exposure when comparing estimates of effect which some previous reviews have not done.[5] For the same level of maternal smoking, exposure to environmental tobacco smoke as assessed by cotinine levels declines markedly between infancy and school age.[111]

Even after school entry there is evidence that exposure (as assessed by salivary cotinine levels) continues to fall and there is evidence of both differential exposure by sex and by geographical area and time of year.[110 112 113] This fall in cotinine with age is consistent with data from the large nationwide US study[88] which strongly suggests that the adverse effect of parental smoking on respiratory symptoms in their children falls with age even amongst school children. This may reflect reduction in exposure because they are spending less time with their parents, or to maturation of the respiratory system, or both.

PUBLICATION BIAS

There is clear evidence of publication bias, particularly for wheeze, in that small studies were only published if they had high odds ratios. However, this will have had minimal effect on our pooled estimates of odds ratios unless publication bias also existed for larger studies. The data from the EC study are reassuring in this respect because they were not subject to publication bias. The odds ratio for wheeze ever from the EC studies based on some 22 000 children is almost identical to that from our analysis of studies published in journals.

Conclusions

The effects of passive smoke exposure in childhood on the prevalence of respiratory symptoms and asthma are not due to chance and cannot be explained by publication bias or residual confounding with environmental factors. While the relative odds are somewhat smaller than the effects of passive smoking on lower respiratory disease (including wheezing illnesses) in infancy, they apply to common symptoms and the public health burden is thus large.

The prevalence of symptoms ascertained by cross-sectional surveys is determined by both disease incidence and prognosis, and the pattern of morbidity tends to be dominated by a large number of children with relatively mild symptoms. There are indications that exposure to environmental tobacco smoke has a greater effect on more severe wheeze, both within studies where odds ratios were reported for different severity measures and between studies where odds ratios were highest in studies with low prevalence rates of wheeze. Later in this series of systematic reviews we examine data from longitudinal and case-control studies of asthma and wheezing illness in order to distinguish more clearly the effects of parental smoking on measures of incidence, prognosis, and disease severity.

This review was commissioned by the Department of Health. The views expressed are those of the authors and are not necessarily those of the Department of Health. We are indebted to Jenny Taylor and Claire Chazot for their diligent work in assembling the relevant literature and to Iain Carey for assistance with the figures.

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